FOLDING MACHINE WITH REMOVABLE PLATE

The present invention pertains to a paper-folding machine, and in particular a paper-folding machine having at least one removable plate.

Background of the Invention

Paper folding machines are known that provide for C-folds, Z-folds and half-folds. For example, U.S. Patent No. 5,554,094, which is incorporated herein by reference, discloses the processing of paper sheets to provide different types of folds. In the Z-fold format, a paper sheet is folded twice to form three sections with the ends of the sheet along opposite sides of the center section. In a C-fold format, the sheet is folded twice with its ends inward and overlapping each other to form three sections. In a half-fold format with a paper sheet is folded once to form two sections. The sheets can also be folded with or without inserts inserted therein.

Referring to FIGS. 1A and 1B a prior-art folding apparatus 12 is shown set up to form a paper sheet with a Z-fold. The folding apparatus 12 has a supply device 42, a folding device 44 and an output device 46. The supply device 42 accepts a paper sheet 28 from a conveyor system with the document 18 in flat condition with an insert 26 thereon. The trailing edges of the document 18 and insert 26 are aligned to form a trailing edge 48 of the paper sheet 28 spaced from a leading edge 50 thereof. The supply device 42 includes a supply guide 52 with a supply conveyor 54 thereabove. The supply conveyor 54 has two pusher devices 56 thereon moving in the clockwise direction in FIG. 1A. One of the pusher devices 56 engages the trailing edge 48 of the paper sheet 28 to move the paper sheet 28 into a nip 58 formed by cooperating upper and lower rollers 60, 62 of the folding device 44 with the trailing edge of the document 18 and insert aligned as indicated by position 5a in FIG. 1B. The upper roller 60 continually rotates clockwise while the lower roller 62 continually rotates counterclockwise, as viewed in FIG. 1A, to accept the paper sheet 28 from the supply device 42.

Along the path of the paper sheet 28 through the folding apparatus 12, the folding device 44 has first, second and third stations 64, 66, 68, respectively. Various operations can be performed at these stations, depending upon how the folding device 44 is arranged, to fold the paper sheet 28 in one of the Z-fold, C-fold or half-fold formats.

In FIG. 1A, the folding device 44 has been set up to perform a Z-fold on the paper sheet 28. To perform a Z-fold on the paper sheet 28, the first station 64 is set up with a diverting device 70 and a buckle plate 72. The diverting device 70 is for diverting the leading edge 50 of the paper sheet 28 as the paper sheet 28 moves in a first path (see position 5a) and changing a direction of movement of the leading edge 50 to a second path (see position 5b) into the buckle plate 72. The diverting device 70 is moveable between an operative position (shown in solid line in FIG. 1A) in the first path of the paper sheet 28 as the leading edge 50 thereof exits from the conveyor system and an inoperative position (shown in phantom line in FIG. 1A) spaced from the first path of the paper sheet 28.

The buckle plate 72 has an adjustable stop 74 positionable by the user depending upon the size of the paper sheet 28. After the paper sheet 28 enters the buckle plate 72, the diverting device 70 moves to its inoperative position shown in phantom line in FIG. 1A. This movement is accomplished pneumatically and is controlled by a computer processing unit which is signalled by an appropriately located sensor (not shown) to detect the passage of the leading edge 50 of the paper sheet 28. With the diverting device 70 in its inoperative position, the leading edge 50 will engage the adjustable stop 74 to stop further movement of the paper sheet 28 in the second path. However, the cooperating rollers 60, 62 continue to drive the paper sheet 28 causing an intermediate portion of the paper sheet 28 between the leading and trailing edges 50, 48 thereof to engage a nip 76 formed by cooperating upper and lower rollers 78,80. The upper roller 78

continually rotates clockwise while the lower roller 80 continually rotates counterclockwise, as viewed in FIG. 1A, to accept the paper sheet 28 and create a first folded edge 82 therein as shown at position 5c as the paper sheet 28 is drawn through the nip 76 in a third path.

At the second station 66, a buckle plate 84 has been set up to accept the paper sheet 28 coming from the cooperating rollers 78, 80 in the third path. The buckle plate 84 has an adjustable stop 86 in the third path for stopping movement of the folded edge 82 of the paper sheet 28 along the third path as shown in position 5d. After the folded edge 82 of the paper sheet 28 is stopped, the cooperating rollers 78,80 drive the intermediate portion of the paper sheet 28 between a nip 88 formed between the lower roller 80 and a roller 90 (position 5e). The roller 90 is continually driven in a clockwise direction, as viewed in FIG. 1A. The rollers 80, 90 draw the paper sheet 28 through the nip 88 in a fourth path to create a folded edge 92 at the intermediate portion of the paper sheet 28 between the folded edge 82 and the trailing edge 48 thereof (position 5e).

As the paper sheet 28 enters the third station 68, a first bypass device 91 located in the fourth path after the nip 88 deflects the paper sheet 28 into a nip 94 formed between the roller 90 and a roller 96. The roller 96 is continually driven in a counterclockwise direction, as viewed in FIG. 1A. The rollers 90, 96 draw the paper sheet 28 through the nip 94 sending the paper sheet 28 into the output device 46. The output device 46 includes an output guide 98 and an output conveyor 100 designed to deliver the paper sheet 28 to the enveloper as shown by position 5f. Thus, a Z-folded paper sheet is formed.

In FIGS. 2A and 2B the folding apparatus 12 is arranged to provide C-folding. It should be noted that a second bypass device 102 has been mounted at the second station 66 while a buckle plate 104 has been mounted in the third station 68. The buckle plate 104 has an adjustable

stop 106 positionable by the user depending upon the size of the paper sheet 28. After the paper sheet 28 enters the folding apparatus 12, the diverting device 70 diverts the leading edge 50 of the paper sheet 28 as the paper sheet 28 moves in a first path (see position 6a) and changes a direction of movement of the leading edge 50 to a second path (see position 6b) into the buckle plate 72. The diverting device 70 moves from its operative position (shown in solid line in FIG. 2A) in the first path of the paper sheet 28 as the leading edge 50 thereof exits from the conveyor system, to its inoperative position (shown in phantom line in FIG. 2A) spaced from the first path of the paper sheet 28. With the diverting device 70 in its inoperative position, the leading edge 50 will engage the adjustable stop 74 to stop further movement of the leading edge 50 of the paper sheet 28 in the second path. The cooperating rollers 60,62 continue to drive the paper sheet 28 causing an intermediate portion of the paper sheet 28 between the leading and trailing edges 50, 48 thereof to engage the nip 76 formed by cooperating upper and lower rollers 78,80 to create a first folded edge 82 therein as the paper sheet 28 is drawn through the nip 76 in a third path.

At the second station 66, the second bypass device 102 has been set up to accept the paper sheet 28 coming from the cooperating rollers 78, 80 in the third path. The second bypass device 102 located in the third path after the nip 76 deflects the paper sheet 28 into the nip 88 formed between the rollers 80, 90 (position 6c).

At the third station 68, the paper sheet 28 enters the buckle plate 104 travelling in a fourth path (position 6d). When the folded edge 82 of the paper sheet 28 engages the adjustable stop 106, further movement thereof in the fourth path is stopped. However, the cooperating rollers 90,96 drive the intermediate portion of the paper sheet 28 between the nip 94, the rollers 90,96 drawing the paper sheet 28 through the nip 94 in a fifth path to create a folded edge 108 at the

intermediate portion of the paper sheet 28 between the folded edge 82 and the trailing edge 48 thereof. The paper sheet 28 is delivered into the output device 46. Thus, a C-folded paper sheet is formed.

In FIGS. 3A and 3B the folding apparatus 12 is arranged to provide half-folding with a thru feed. It should be noted that the second bypass device 102 has been mounted at the second station 66 while the first bypass device 91 has been mounted in the third station 68. After the paper sheet 28 enters the folding apparatus 12, the diverting device 70 diverts the leading edge 50 of the paper sheet 28 as the paper sheet 28 moves in a first path (see position 7a) and changes a direction of movement of the leading edge 50 to a second path (see position 7b) into the buckle plate 72. The diverting device 70 moves from its operative position (shown in solid line in FIG. 3A) in the first path of the paper sheet 28 as the leading edge 50 thereof exits from the conveying station to its inoperative position (shown in phantom line in FIG. 3A) spaced from the first path of the paper sheet 28. With the diverting device 70 in its inoperative position, the leading edge 50 will engage the adjustable stop 74 to stop further movement of the leading edge 50 of the paper sheet 28 in the second path. The cooperating rollers 60, 62 continue to drive the paper sheet 28 causing the intermediate portion of the paper sheet 28 between the leading and trailing edges 50, 48 thereof to engage the nip 76 formed by cooperating upper and lower rollers 78, 80 to create a folded edge 110 therein as the paper sheet 28 is drawn through the nip 76 in a third path.

At the second station 66, the output conveyor 100 has been set up to accept the paper sheet 28 coming from the cooperating rollers 78, 80 in the third path. The second bypass device 102 located in the third path after the nip 76 deflects the paper sheet 28 into a fourth path between the nip 88 formed by the rollers 80, 90 (position 7c).

As the paper sheet 28 enters the third station 68, the first bypass device 91 located in the fourth path after the nip 88 deflects the paper sheet 28 into the nip 94 formed between the roller 90 and a roller 96 (position 7e). The rollers 90, 96 draw the paper sheet 28 through the nip 94 sending the paper sheet 28 into the output device 46. Thus, a half-folded paper sheet is formed.

In FIGS. 4A and 4B the folding apparatus 12 is arranged to provide half-folding with a downward feed direction. This format of folding cannot be accomplished with an insert forming part of the paper sheet 28, i.e., the paper sheet 28 is insertless. It should be noted that the buckle plate 84 has been mounted at the second station 66 while the bypass device 91 has been mounted in the third station 68. Also, the diverting device 70 and buckle plate 72 have been removed. Alternatively, the diverting device 70 can merely be placed in its inoperative position. After the paper sheet 28 enters the folding apparatus 12, the cooperating rollers 60, 62 move the paper sheet 28 in a first path (see position 8a) to engage the nip 76 formed by cooperating upper and lower rollers 78, 80.

As the paper sheet 28 is drawn through the nip 76, the buckle plate 84 at the second station 66 accepts the paper sheet 28 coming from the cooperating rollers 78, 80. The adjustable stop 86 stops the movement of the leading edge 50 of the paper sheet 28 as shown in position 8c. After the paper sheet 28 is stopped, the cooperating rollers 78, 80 drive the intermediate portion of the paper sheet 28 between the nip 88 formed between the rollers 80, 90. The rollers 80, 90 draw the paper sheet 28 through the nip 88 to create a folded edge 112 at the intermediate portion of the paper sheet 28.

As the paper sheet 28 enters the third station 68, the first bypass device 91 located after the nip 88 deflects the paper sheet 28 into the nip 94 formed between the rollers 90, 96 (position

8d). The rollers 90, 96 drawing the paper sheet 28 through the nip 94 sending the paper sheet 28 into the output device 46. Thus, a half-folded paper sheet is formed.

In FIGS. 5A and 5B the folding apparatus 12 is arranged to provide half-folding with an upward feed direction. This format of folding cannot be accomplished with an insert forming part of the paper sheet 28, i.e., the paper sheet 28 is insertless. It should be noted that the second bypass device 102 has been mounted at the second station 66 while the buckle plate 104 has been mounted in the third station 68. Also, the diverting device 70 and buckle plate 72 have been removed. Alternatively, the diverting device 70 can merely be placed in its inoperative position. After the paper sheet 28 enters the folding apparatus 12, the cooperating rollers 60, 62 move the paper sheet 28 in a first path (see position 9a) to engage the nip 76 formed by cooperating upper and lower rollers 78, 80.

As the paper sheet 28 is drawn through the nip 76, the bypass device 102 at the second station 66 located after the nip 76 deflects the paper sheet 28 into the nip 88 formed between the rollers 80, 90 (position 9b). At the third station 68, the paper sheet 28 enters the buckle plate 104 (position 9c). When the paper sheet 28 engages the adjustable stop 106, further movement of the leading edge 50 is stopped. However, the cooperating rollers 90, 96 drive the intermediate portion of the paper sheet 28 between the nip 94. The rollers 90, 96 drawing the paper sheet 28 through the nip 94 to create a folded edge 114 at the intermediate portion of the paper sheet 28. The paper sheet 28 is delivered into the output device 46. Thus, a half-folded paper sheet is formed.

Such known folding machines as discussed above require complicated and expensive electronic controls and sensors in order to provide for the proper processing of the paper sheets. As well, such known folding machines have many plates and other components that must be

disassembled when repair or cleaning of the internal parts of the machine is required or to alleviate paper jams. As such plates may be very heavy, operators of the machine may find it difficult to remove the plates, even after disassembly is accomplished.

Therefore, there is desired a paper folding machine that provides for all of the above described folding functions, but provides for inexpensive, uncomplicated processing mechanisms while allowing for easy access to the internal parts of the folding machine when cleaning or repairs are necessary. There is also desired automatic mechanical means for processing different sizes and types of paper sheets.

Summary of the Invention

The above disadvantages are overcome by the present invention that provides for a folding machine comprising a housing having an upper opening, a processing area including a split table disposed in the housing having a first removable plate and a second removable plate accessible through the upper opening, a paper input area adjacent the first plate and a paper output area adjacent the second plate. In an embodiment, the split table includes a first fold plate and a second fold plate and the first removable plate is removably attached to the first fold plate and the second removable plate is removably attached to the second fold plate. In an embodiment, the split table is formed generally in a V-shape. In an embodiment, a main roller is disposed between the first and second fold plates.

In an embodiment, the main roller is mounted at the vertex formed by the V-shaped first and second fold plates. In an embodiment, the first and second fold plates include a paper stop for processing paper sheets received therein. In an embodiment, the first and second removable plates include paper sizing indicia. In an embodiment, the first and second removable plates include type-of-fold indicia. In an embodiment, the first and second fold plates include an adjuster. In an embodiment, the adjuster provides for adjustment of the paper stop according to

the type-of-fold indicia and/or paper size indicia provided by the corresponding removable plate. In an embodiment, the adjuster provides for a fold including one of a C-shaped, D-shaped, G-shaped or Z-shaped fold.

In an embodiment, the adjuster provides for adjustment of the paper size or fold type processed by the paper stop. In an embodiment, the adjusters are each slidingly mounted within a slot formed in each of the first and second fold plates. In an embodiment, the adjuster controls the position of the paper stop and an indicia indicator attached thereto. In an embodiment, the fold deflector includes a rigid finger including a stop surface against which a paper sheet abuts in order to fold the sheet.

In an alternate form of the invention a paper folding machine is provided comprising a housing, a lower fold plate disposed within the housing, the lower fold plate providing a work area, a paper stop adjustably mounted to the lower fold plate, an upper plate removably mounted to the lower fold plate and partially enclosing the work area, a roller for advancing paper into the work area and the paper sheet contacting the fold plate in order to fold the paper and an output area for receiving the folded paper.

In an embodiment, the folding machine further comprises an adjuster connected to the paper stop, a slot formed in the upper plate for receiving the adjuster therethrough so that the paper stop may be adjusted from outside the work area without removing the upper plate and the upper plate may be easily removed without requiring disassembly of the adjuster or paper stop. In an embodiment, the slot is arranged vertically along the upper plate. In an embodiment, fold indicia may be provided on the upper plate adjacent the slot in order to identify the positioning of the adjuster. In an embodiment, the machine further comprises a split table having a first side

and a second side wherein the first side includes a first lower fold plate and a first upper plate and the second side includes a second lower fold plate and a second upper plate mounted thereto.

In an embodiment, the machine includes a central roller disposed between the first lower fold plate and the second lower fold plate for feeding paper between the first side and second side of the split table. In an embodiment, an input table is adjacent the first side and an output table is adjacent the second side.

Brief Description of the Drawings

For the purpose of facilitating an understanding of the subject matter sought to be protected, there are illustrated in the accompanying drawings embodiments thereof, from an inspection of which, when considered in connection with the following description, the subject matter sought to be protected, its constructions and operation, and many of its advantages should be readily understood and appreciated.

FIG. 1A is a fragmentary, diagrammatic, side elevational view of a prior-art folding apparatus set up to create a Z-folded product;

FIG. 1B is a schematic diagrammatic view of the product as it is processed through the apparatus of FIG. 1A to create a Z-folded product;

FIG. 2A is a view similar to FIG. 1A, with the apparatus set up to create a C-folded product;

FIG. 2B is a schematic diagrammatic view of the product as it is processed through the apparatus of FIG. 2A to create a C-folded product;

FIG. 3A is a view similar to FIG. 1A with the apparatus set up to create a half-folded product utilizing a thru feed path;

FIG. 3B is a schematic diagrammatic view of the product as it is processed through the apparatus of FIG. 3A to create a half-folded product;

FIG. 4A is a view similar to FIG. 1A with the apparatus set up to create a half-folded product utilizing a downwardly directed fold path;

FIG. 4B is a schematic diagrammatic view of the product as it is processed through the apparatus of FIG. 4A to create a half-folded product;

FIG. 5A is a view similar to FIG. 1A with the apparatus set up to create a half-folded product utilizing an upwardly directed fold path;

FIG. 5B is a schematic diagrammatic view of the product as it is processed through the apparatus of FIG. 5A to create a half-folded product; and

FIG. 6 is a perspective view of a folding machine of the present invention;

FIG. 7 is an enlarged perspective view of the folding machine of FIG. 6 showing an upper plate of the folding machine removed;

FIG. 8A is a plan view of a first plate of the folding machine of FIG. 6;

FIG. 8B is a plan view of a second plate of the folding machine of FIG. 6;

FIG. 9 is a fragmentary, perspective view of the folding machine of FIG. 6 showing the paper supply plate of the folding machine;

FIG. 10 is a fragmentary, perspective view of the folding machine of FIG. 6 showing the stacking plate and stacking arm of the folding machine;

FIG. 11 is a side elevational diagrammatic view of the folding machine of FIG. 6 depicting multiple positioning of the stacking arm;

FIG. 12 is an enlarged perspective view of a roller cartridge for use in the folding machine of FIG. 6; and

FIG. 13 is an enlarged plan view of an alternate embodiment of a roller cartridge for use in the folding machine of FIG. 6.

Detailed Description

The present invention is described with respect to FIGs. 6-13. Like numerals for like elements are used throughout all FIGs. 6-13. A paper-folding machine 210 is provided having a housing 215 including a first sidewall 216 and a second sidewall 217. The housing 215 forms an upper opening 218. A V-shaped upper split table 220 provides a paper processing area that is disposed between the first sidewall 216 and second sidewall 217 and is accessible through the upper opening 218. The split table 220 is formed by lower fold plates 222a, b and upper removable plates 224a, b. In an embodiment, a first upper removable plate 224a is disposed on first lower fold plate 222a forming a right side work area, pocket or chamber 221a and a second upper removable plate 224b is disposed on a second lower fold plate 222b forming a left side work area, pocket or chamber 221b (FIG. 7).

First slots 225a, b are formed in the upper plates 224a, b. First slot 225c (FIG. 7) is formed in the lower plate 222a, b. Second slots 227a, b are also formed in the upper plates 224a, b. First chutes 231a, b are formed on one side of the slot 225a, b and second chutes 232a, b are formed on the opposite side of the slot 225a, b. Corresponding to the chutes 232a, b and formed on the lower fold plates 222a, b are first channels 234a, b and second channels 236a, b. Disposed behind the lower fold plate 222a, b are paper stops 240a, b that in an embodiment are each mounted on an adjustment rod, explained further below. Each paper stop 240a, b includes an adjuster 242a, b that protrudes through slots 225a, b, respectively. Fingers 244a, b, 246a, b are disposed on the paper stop 240 a, b and protrude through the channels 234a, b, and 236a, b, respectively. In an embodiment, the fingers 244a, b, 246 a, b are integrally formed with the major surface of the paper stop 240a, b and protrude at a right angle therefrom. In an embodiment, the paper stop 240a, b may be formed of a polymer material.

The adjuster 242a, b, in an embodiment, is a lever which may be moved between a locked condition and an unlocked condition. The adjuster lever 242a, b may be grabbed between an operator's fingers and in the unlocked condition may slide the paper stop 240a, b along the plates 222a, b, and 224a, b so that the fingers 244a, b, 246a, b simultaneously move along channels 234a, b, 236a, b. In an embodiment, each adjuster 242a, b includes a lever and a tab 239a, b mounted to the paper stop 240a, b. The adjuster lever 242a pivots between a locked condition, parallel to the plane of the paper stop (as shown in FIG. 7) and an unlocked condition, perpendicular to the plane of the paper stop and parallel to the tab (as shown in FIG. 6 and also perpendicular lever 242b in FIG. 7). An actuator 243b (FIG. 7) attached to the lever 242b, engages an adjustment rod 261a, b when the lever 242b is in a locked condition in order to lock the paper stop 240a, b in a predetermined position along the adjustment rod 261a, b. Pivoting the lever 242a, b to the unlocked condition causes the actuator 243b to release from the adjustment rod 261a, b, so that the paper stop 240a, b may be slid up and down along the adjustment rod 261a, b and along the slots 225a, b, c. In an embodiment, when the lever 242a, b is in its unlocked, perpendicular condition, a user may simultaneously grasp the lever 242a, b and tab 239a, b between his/her fingers in order to adjust the paper stop 240a, b along the lower fold plates 222a, b.

During operation of the folding machine, paper may abut the fingers 244a, b, 246a, b of the paper stop 240a, b at predetermined locations, arrived at by moving the adjuster 242a, b. The fingers 244a, b, 246a, b include stop surfaces that act to deflect, buckle or stop paper sheets circulating in the folding machine 210 in order to form a nip at the side of the sheet opposite the stop surface, in order to fold the sheets at predetermined locations and fold types. In an embodiment, paper sheets are processed first in left pocket 221b and secondly in right pocket

221a. The folds are formed and paper sheets are processed generally as discussed above for Figs. 1A-5B. In an embodiment, the paper stop 240a, b may have both a folding function and an adjustment function. In an alternate embodiment, the paper stop 240a, b may only act to fold paper sheets and a separate component acts as an adjustment bar for adjusting the positioning of the paper stop. A sound deadening medium 248a, b such as a sound deadening paper or acoustic foam is located under the lower fold plates 222a, b.

A roller cover 250 is located between the plates 222a, b, 224a, b and in an embodiment, is attached to the upper plate 224b. Located under the roller cover (FIG. 7) is a feeding mechanism, for example, a main roller 252. A main roller gear 253 (FIG. 6) is attached to the main roller 252. A secondary roller 254 is located adjacent to the main roller 252 and a secondary roller wheel 255 is attached thereto. As well, a tertiary roller 256 (FIG. 10) is provided and includes a tertiary roller gear 257 (FIG. 6). These rollers act to propel the paper sheets between the fold plates 222a, b, 224a, b and to form nips in order to fold the paper sheets.

An adjustment knob 260a, b is mounted at the terminal end of each upper plate 224a, b. Whereas the adjusters 242a, b provide for large or gross adjustment of the paper stops 240a, b; the adjustment knobs 260a, b provide for fine adjustment of the paper stops 240a, b. In an embodiment, by rotating the knobs 260a, b either clockwise or counterclockwise the paper stops 240a, b may be adjusted by millimeter increments to adjust for different paper weights/bond types. Each adjustment knob 260a, b is attached to adjustment rods 261a, b, respectively, upon which the paper stop 240a, b is mounted. In an embodiment, the adjustment rod 261a, b is mounted adjacent to the lower fold plate 222a, b and extends between the terminal edge 262a, b and proximal edge 263a, b of the lower fold plates 222a, b (as shown in FIG. 10). In an embodiment, the paper stop includes a means for threadingly receiving threaded portions of the

adjustment rod 261a, b so that upon rotation of the knob 260a, b, the paper stop 240a, b will be moved incrementally either up or down along the lower fold plate 222a, b.

A quick-coupling mechanism, for example, attachment levers 265a, b are also provided at the terminal end of the upper plates 224a, b. The attachment lever 265a, b, in an embodiment, is a pivoting lever which has a locked and unlocked condition. The upper plates 224a, b may be quickly and easily mounted on the lower fold plates 222a, b and secured thereto by locking the attachment levers 265a, b. In an embodiment, each attachment lever 265a, b has a swell latch having an expander 266b (see FIG. 8) that latches within an aperture 267b at the terminal edge 262b of each lower fold plate 222a, b when the pivoting lever 265a, b is in its locked condition positioned horizontal to the edge of the upper plate 224a, b (as shown in FIGS. 6, 8, 10). To unlatch the attachment lever 265a, b and move it to its unlocked condition, a pivot lever 265a, b is grasped between a user's fingers and moved to a position vertical to the edge 262a, b (FIG. 6) of the upper plate 224a, b, which causes an expander 266b (FIG. 8) to unlatch from an aperture 267b formed at the terminal edge 262b of the lower fold plate 222b, so that upon continued pulling on the pivot lever 265a, b by a user's fingers, the upper plate 224a, b may be quickly removed from the lower fold plate 222a, b. For example, each expander 266b may include a resilient sleeve 268b having a hook 269b (FIG. 8) inside so that the sleeve 268b is caused to expand by movement of the hook 269b when the attachment lever 265a, b is in its locked condition. The sleeve 268b may be contracted by movement of the hook 269b when the attachment lever 265a, b is in its unlocked condition. Thus, for each attachment lever 265a, b a two-step removal process is provided, consisting of 1) unlocking the adjustment lever 265a, b and 2) removing the upper plate 224a, b from the lower plate 222a, b. Other known fasteners may also be used for the adjustment lever 265a, b. Thus, the present invention provides for

upper plates 224a, b that are quickly and easily removable and reattachable to the folding machine 210.

In an embodiment, the upper plate 224a, b contains few components and is very lightweight. In an embodiment, each upper plate 224a, b is made of metal and weighs less than 5 lbs. Thus, when repair of the machine 210, is required, the upper plates 224a, b can be quickly and easily removed so that the main roller 252 and the paper stops 240a, b may be exposed. These are areas where cleaning is required and paper jams may frequently occur that can be quickly and easily rectified with the construction of the present invention. The construction of the plates 222a, b, 224a, b having slots 225a, b, c, 227a, b allow for access to the adjuster 242a, b and indicator 272a, b from above the upper plates 224a, b, even though such structures are not carried by the upper plates 224a, b. Because these elements 242a, b, 272a, b, and the paper stops 240a, b are supported by the lower fold plate 222a, b; the upper plate 224a, b is lightweight and can be quickly and easily removed. This construction also allows for the lower plates 222a, b, in an embodiment, to be welded to the housing 120 and side walls 216, 217 to provide for a very rigid folding machine structure that allows for the processing of paper sheets with precise, square folds.

As shown in FIG. 7 and FIG. 8 the upper plates 224a, b include type of fold indicia and paper size indicia 270a, b. In an embodiment, the type of fold and paper size indicia 270a, b are numbers and letters printed on the face of the upper plate 224a, b adjacent the slots 227a, b. In an embodiment, the indicia may be printed directly onto the plate or attached by a label or decal. Protruding through the slots 227a, b and adjacent the indicia 270a, b are indicia indicators 272a, b which, in an embodiment, are attached to the paper stop 240a, b. Upon movement of the paper stop 240a, b, the indicia indicator 272a, b simultaneously moves and provides an indication of

the type of fold or size of fold that the location of the paper stop 240a, b will provide in that specified position. For example, as shown in FIG. 8b, the top indicia "17 Z" indicates that a Z-type fold with 17 inch paper will be provided for, when the paper stop 240b is moved to the upper most position. For example, the indicia 270b indicate "14 Z" (Z-type fold with 14 inch paper), "11 Z" (Z-type fold with 11 inch paper), "14 D" (D-type fold with 14 inch paper), "17 C" (C-type or Correspondence fold with 17 inch paper), "14 C" (Correspondence fold with 14 inch paper), "17 G" (G-type fold with 17 inch paper), "11 C" (Correspondence fold with 11 inch paper), "14 G" (G-type or gate fold with 14 inch paper), and "11 G" (G-type fold with 11 inch paper). Other indicia and other sequencing of the indicia may be provided. In an embodiment, the upper left side pocket 221b and plates 222b and plates 224b are not used to provide half folds. In order to adjust the machine to provide half folds the paper stop 240b is moved to the bottom of the plate in order to act as a deflector from the first fold pocket so that paper sheets go directly to the second or right side fold pocket 221a of the fold plate 222a (FIG. 8a) where half folds may occur. In an embodiment, the indicia 270a of the upper plate 224a will include half fold and gate fold indicia for 17", 14" and 11" size sheets, a D-type or double parallel fold position for 14 inch sheets as well as the indicia 270a, described above for C-type and Z-type folds. It is noted that the arrangement of the indicia 270a on the first removable plate 224a is organized differently than the indicia 270b on the second removable plate 224b because the position of the paper stop 240a, b in order to accomplish such fold types varies from the right side fold pocket 221a to the left side fold pocket 221b.

Turning to FIG. 9, a supply plate or input table 280 provides a paper input feeding or receiving area having paper width guides 282a, b. In an embodiment, the supply plate 280 may be adjustable upward and downward. Mounted between the first and second sidewall 216, 217 is

a paper supply roller 284. The roller 284 includes wheels 286 for injecting paper sheets 288 into the fold machine 210. Protruding from the second sidewall 217 are a power gear 290, a drive mechanism 292, a central drive gear 294 and a control panel 296 for controlling the operation of the folding machine 210.

Turning to FIG. 10, a stacking plate or table 300 provides a paper output area including a first belt 301, second belt 302 and third belt 303 for pulling paper from the folding machine 210 and for stacking folded sheets on the stacking plate 300. The stacking plate 300 is pivotally mounted between the sidewalls 216, 217 via pin 304 received in channel 305. A stacking arm 310 is provided which includes a pivot arm 312, support arm 134 and stacking rollers 316a, b attached to the support arm 314 by a rod 318. The stacking arm 310 operates in order to help compress the finished folded sheets (not shown) and to help stack them on the stacking plate 300. The stacking arm 310 is automatically adjusted in order to position the rollers 316a, b in the proper position on the stacking plate 300 according to the size of the paper being ejected from the machine 210 and according to the positioning of the paper stop 40a, b.

A housing frame 320 is provided between the first sidewall 216 and second sidewall 217. Attached to the housing frame 320 is a hinge 322. Attached to the hinge 322 is the pivot arm 312. Within the pivot arm is provided a slide track 326. In an embodiment a sliding or adjustment arm 324 is attached to the pivot arm 312 via a bearing slider 326 mounted in a track of the pivot arm 312 providing a pivot joint 328. At the end opposite the pivot joint 328, the sliding arm is attached to a paper stop box 330. In an embodiment, the paper stop box 330 includes threaded bores which receive threaded portions of the rod 261a therethrough. The paper stop box 130 is also attached to the paper stop 240a.

Operation of the stacking arm 310 will be discussed with respect to FIGs. 10 and 11. When the paper stop 240a is adjusted via the adjuster 242a, b (FIG. 6, 9) discussed above, it will simultaneously move the paper stop box 330 up and down along the rod 260a, which will simultaneously cause the sliding arm 324 to move. Movement of the sliding arm 324, 324' will cause the bearing slider 326 to slide along the track formed in the pivot arm 312 which will cause the pivot arm 312, 312' to pivot. The stacking arm 310 may be moved inward so that the pivot arm 312 is positioned towards tertiary roller 256 and outward so that the pivot arm 312' is positioned towards the stacking plate 300. Such pivoting of the pivot arm 312, 312' causes the support arm 314, 314' to be in an inward position 314 and an outward position 314' that simultaneously moves the roller 116a, closer in towards first belt 301 or to a position 316a' further out on the stacking plate 300 towards its terminal end. (Although FIG. 6 only depicts two positions of the stacking arm 310, it is to be understood that multiple positions may be provided during continuous movement of the arm 310.)

For example, when a small sheet or small fold type is requested, such as "8.5 x 14 D", as shown on FIG. 8a, the paper stop 240a is located towards the bottom of the plate 224a. As shown in FIG. 10, this position will draw the pivot arm 312 closer into the machine, towards the tertiary roller 256. Simultaneously, the stacking rollers 316a, b will also be moved inward, in order to be positioned to receive the shorter "8.5 x 14 D" type sheets exiting the machine on the first belt 301. When a larger type fold or larger sheet size is being processed by the machine, the paper stop 240a, will be positioned towards the upper terminal end of the upper plate 224a, for example, at the "11 x 17 half, gate" designation, as shown on FIG. 8a. This positioning of the paper stop 240a will cause the sliding arm 324' to move the pivot arm 312' and the stacking roller 316a' outward in order to position it further down the stacking plate 300 to receive the

longer "11 x 17 half, gate" type sheets which will extend further down on the stacking plate 300. Therefore, it may be understood that when the machine is adjusted for the specified fold types or paper sizes by movement of the paper stop 240a, the stacking arm 310 is also automatically adjusted for the stacking of the specified folded papers when they exit the folding machine at the stacking plate 300. Such positioning of the stacking arm 310 and rollers 316a, b will provide for neatly shingled, stacked paper sheets on the stacking tray 300.

In an embodiment, the stacking arm 310 may include a quick release 328 so that the arm 310 may be disengaged from the paper stop 240a and the arm 310 may be operated independently. For example, if a non-standard paper size or paper fold is being processed by the machine 210, it may be desirable to be able to independently set the stacking arm 310 in particular positions on the stacking plate 300, that would not be provided automatically if the arm 310 were attached to the paper stop 240a. In an embodiment, the pivot joint 328 may have associated with it, a quick release pin 329 inserted between the sliding arm 324 and the pivot arm 312. A ring 331 attached to the pin 329 may be pulled to quickly remove the pin 329 so that the pivot arm 312 is disengaged and detached from the sliding arm 324. After release of the pin 329, the stacking arm 310 may be positioned independently from the paper stop 240, to which the sliding arm 324 is attached. In an embodiment the pin 329 will be attached to the housing via a tether, so that the pin 329 cannot be misplaced after removal from the pivot arm 312. A tension knob 327 may be rotated in order to hold the stacking arm 310 in a desired position after manual adjustment.

Turning to FIG. 12, a first roller cartridge 330 is disclosed. FIG. 12 depicts an enlarged view of the roller 256, that is also shown in FIG. 10. The cartridge includes a frame 332a, b and the tertiary roller 256 is mounted therebetween. A pair of feed rollers 334, 336 are also mounted

between the frame 332a, b on either side of the tertiary roller 256. Each of the feed rollers 334, 336 include wheels 337, 338, 339 which help to maintain paper sheets in contact with the tertiary roller 256 in order to help the paper sheets feed therethrough. A guide plate 340 is mounted to and extends between the frame 332a, b and also helps to guide paper sheets through the rollers 256, 334, 336.

Attached to the frame 332a, b are mounting members 341, 342. In an embodiment, the mounting members 341, 342 form U-shaped hooks which help to mount the cartridge 330 within a paper folding machine. As well, each of the frames 332a, b includes a tab 345 having an aperture 347 formed therein. In an embodiment, upon mounting of the first cartridge 330 within the paper folding machine 210, the frames 332a, b are aligned with the sidewalls 216, 217 so that the mounting members 341, 342 are mounted over posts protruding from the sidewalls 216, 217. Simultaneously, the aperture 347 is aligned with a hole in the wall 216, 217 so that a fastener 348 may be inserted therethrough in order to secure the cartridge 330 within the housing of the paper folding machine. In an alternate embodiment, the cartridge 330 may be mounted permanently within the paper folding machine such as by welding the frame 332a, b to the sidewalls 216, 217.

Turning to FIG. 13, an alternate embodiment of a second cartridge 350 is shown. The second cartridge 350 includes a frame 352a, b and a guide plate 354 which are similar to the frame and guide plate discussed above for FIG. 12. Mounted between the frame 352a, b are a feed roller 355 and cutting rollers 361, 362. The first cutting roller 361 includes cutting wheels 363, 364 which engage cutting wheels 365, 366 respectively which are mounted on the second cutting roller 362. In an embodiment, the cutting wheels 363, 364 include annular blades 367a, b which engage annular grooves 368a, b, respectively, on the corresponding cutting wheels 365, 366. Paper sheets are fed through each of these wheels 363, 364, 365, 366 and the paper sheets

are slit by the blades 367a, b. Each of the wheels 363, 364, 365, 366 are adjustable along the rollers 361, 362, respectively. For example, a fastener 370, such as a screw, having an Allen wrench receptacle is provided, so that the wheels 363, 364, 365, 366 may be positioned and locked in place by tightening the fastener 370. By sliding the wheels 363, 364, 365, 366 along the length of the shaft of cutting rollers 361, 362, a multitude of positions for slits may be provided on the paper sheets fed therethrough.

In an alternate embodiment, the cutting wheels 363, 364, 365, 366 may be replaced by other types of wheels which may provide for serrations, perforations or other processing of paper sheets. The second cartridge 350 may also be replaceable and have mounting members and apertures as discussed for the first cartridge 330 of FIG. 12. As well, in an embodiment, the second cartridge 350 may be interchangeable with the first cartridge 330 and other cartridges having other processing futures such as for perforation or cutting. Therefore, it may be understood that the processing of paper in the paper folding machine may be quickly and easily altered by interchanging the first cartridge 330 with the second cartridge 350 and other types of cartridges. In an embodiment, simply by removing the stacking arm 310, shown in FIG. 10, the first cartridge 330 may be removed and replaced with second cartridge 350. In an embodiment, when a cartridge such as second cartridge 350 is mounted within the paper folding machine, a deflector must be provided in the fold plates so that unfolded paper sheets are received by the second cartridge 350 in order to more easily split, cut or perforate the paper sheets. In an embodiment, a split fold pocket will receive the paper sheets from the fold plate 22b. In a further embodiment, only the cutting rollers 361, 362 may be removable.

The matter set forth in the foregoing description and accompanying drawings is offered by way of illustration only and not as a limitation. While particular embodiments have been

shown and described, it will be obvious to those skilled in the art that changes and modifications may be made without departing from the broader aspects of applicants' contribution. The actual scope of the protection sought is intended to be defined in the following claims when viewed in their proper perspective based on the prior art.